

SNS Linac Technical Memo

D-Plate, Emittance Measurement; Collector Outgassing Rate

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WBS 14.5.2.8 (Diagnostics – D-Plate, Emittance)

Vacuum Loads for SNS D-Plate: Emittance Measurement;
Collector

Summary : In order to do the initial design of the D-plate vacuum system a calculation was done to estimate the out-gassing load from the collector. Also note that as the designs of these devices become more mature, the responsible person should update these values and pass the information on to the vacuum system designers.

The assumptions made were:

Device is mounted on a linear actuator similar to the wire scanner design.

Collector consists of 64 copper strips backed by a PCB material.

64 kapton insulated wires are used to bring signals out of vacuum.

Conclusion

The estimated out-gassing rate for the collector is 1.239×10^{-5} torr*L/s

Inner surfaces exposed to vacuum:

$$\text{Strip}_{\text{Cu}} := 3 \cdot \text{in} \cdot .030 \cdot \text{in} \cdot 64$$

$$\text{Strip}_{\text{Cu}} = 37.16 \text{ cm}^2$$

$$\text{PCB} := (.04 \cdot \text{in} \cdot 64) \cdot 3.02 \cdot \text{in} \cdot 2 - \text{Strip}_{\text{Cu}}$$

$$\text{PCB} = 62.596 \text{ cm}^2$$

$$\text{Guide_rail}_{\text{SA}} := 19.91 \text{ in}^2$$

$$\text{Guide_rail}_{\text{SA}} = 128.45 \text{ cm}^2$$

$$\text{Support}_{\text{SA}} := 84.1 \text{ in}^2$$

$$\text{Support}_{\text{SA}} = 542.58 \text{ cm}^2$$

$$\text{Tube}_{\text{SA}} := \pi \cdot (.625 \cdot \text{in} + .375 \cdot \text{in}) \cdot 14.2 \text{ in}$$

$$\text{Tube}_{\text{SA}} = 287.81 \text{ cm}^2$$

$$\text{Bellows}_{\text{SA}} := \frac{\pi}{4} \cdot \left[(2.2 \cdot \text{in})^2 - (1.04 \text{ in})^2 \right] \cdot 12.2$$

$$\text{Bellows}_{\text{SA}} = 457.058 \text{ cm}^2$$

Leak rate of Copper

$$\text{LR}_{\text{Cu}} := 1.10^{-10} \cdot \frac{\text{torr} \cdot \text{L}}{\text{s} \cdot \text{cm}^2}$$

Total outgassing due to copper

$$\text{OGR}_{\text{Cu}} := \text{Strip}_{\text{Cu}} \text{LR}_{\text{Cu}}$$

$$\text{OGR}_{\text{Cu}} = 3.716 \times 10^{-9} \frac{\text{torr} \cdot \text{L}}{\text{s}}$$

Outgassing rate of exposed stainless steel surfaces

Outgassing rate of stainless steel

$$\text{LR}_{\text{ss}} := 1.10^{-10} \cdot \frac{\text{torr} \cdot \text{L}}{\text{s} \cdot \text{cm}^2}$$

$$\text{OGR}_{\text{ss}} := \text{LR}_{\text{ss}} \cdot (\text{Guide_rail}_{\text{SA}} + \text{Support}_{\text{SA}} + \text{Tube}_{\text{SA}} + \text{Bellows}_{\text{SA}})$$

$$\text{OGR}_{\text{ss}} = 1.416 \times 10^{-7} \frac{\text{torr} \cdot \text{L}}{\text{s}}$$

Outgassing rate of exposed PCB surface

$$\text{LR}_{\text{PCB}} := 26 \cdot 10^{-5} \cdot \frac{\text{W}}{\text{m}^2}$$

$$\text{LR}_{\text{PCB}} = 1.95 \times 10^{-7} \frac{\text{torr} \cdot \text{L}}{\text{s} \cdot \text{cm}^2}$$

$$\text{OGR}_{\text{PCB}} := \text{LR}_{\text{PCB}} \text{PCB}$$

$$\text{OGR}_{\text{PCB}} = 1.22 \times 10^{-5} \frac{\text{torr} \cdot \text{L}}{\text{s}}$$

Seals and their leak rates

$$\text{Bellows} := 2 \cdot 10^{-9} \cdot \frac{\text{torr} \cdot \text{L}}{\text{s}}$$

$$\text{conflat} := 1.10^{-10} \cdot \text{torr} \cdot \frac{\text{L}}{\text{s}}$$

$$\text{viton} := 5 \cdot 10^{-9} \cdot \text{torr} \cdot \frac{\text{L}}{\text{s}}$$

$$\text{bar} := 760 \cdot \text{torr}$$

$$\text{mbar} := .001 \cdot \text{bar}$$

Total surface area of kapton wires

$$\text{Wire} := 64 \cdot \pi \cdot .024 \cdot \text{in} \cdot 12 \text{in}$$

$$\text{Wire} = 373.585 \text{cm}^2$$

$$\text{LR}_{\text{kapton}} := 1.110^{-10} \cdot \frac{\text{mbar} \cdot \text{L}}{\text{s} \cdot \text{cm}^2}$$

$$\text{LR}_{\text{kapton}} = 8.36 \times 10^{-11} \frac{\text{torr} \cdot \text{L}}{\text{s} \cdot \text{cm}^2}$$

$$\text{OGR}_{\text{wire}} := \text{LR}_{\text{kapton}} \cdot \text{Wire}$$

$$\text{OGR}_{\text{wire}} = 3.123 \times 10^{-8} \frac{\text{torr} \cdot \text{L}}{\text{s}}$$

Total Out-gassing rate of the collector system is:

$$\text{OGR}_{\text{collector}} := \text{OGR}_{\text{ss}} + \text{OGR}_{\text{Cu}} + \text{OGR}_{\text{PCB}} + \text{OGR}_{\text{wire}} + \text{Bellows} + 4 \cdot \text{conflat} + \text{viton}$$

$$\text{OGR}_{\text{collector}} = 1.239 \times 10^{-5} \frac{\text{torr} \cdot \text{L}}{\text{s}}$$